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ORIGINAL ARTICLE

Strabismus After Inferior-Medial Wall Orbital Decompression in Thyroid-Related Orbitopathy

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ABSTRACT

Purpose: To evaluate the rate and pattern of new-onset diplopia after inferior-medial wall orbital decompression in thyroid-related orbitopathy (TRO) patients.

Methods: Medical records of TRO patients who underwent orbital floor and medial wall decompression at the Goldschleger Eye Institute, Sheba Medical Center between 1/1986 and 12/2007 were reviewed and analyzed. Main outcome measures: primary- and down-gaze diplopia, strabismus (prism diopter [PD]).

Results: Fifty-one TRO patients (30 females, mean age of 51 years) underwent 102 bilateral inferior-medial wall orbital decompressions. Preoperatively, 29 patients (57%) reported primary gaze diplopia. Of these, 13 patients (45%) had persistent or worsened diplopia postoperatively, all of which required strabismus surgery. Fifteen patients had no primary gaze diplopia preoperatively. Of these, five patients (33%) had new-onset diplopia postoperatively, and only one patient (7%) required strabismus surgery. No data regarding pre-existing diplopia were available in seven patients. Orbital decompression had a significant effect on horizontal ocular deviations with increasing esotropic shift. Primary position esotropia increased from 11.1 (± 22.5) PD preoperatively to 23.8 (± 20.5) PD after surgery ($p = 0.01$, paired samples t-test). No severe complications were encountered in this group of patients.

Conclusions: Inferior-medial wall orbital decompression is associated with a relatively high rate of new-onset diplopia of up to 33%. Patients with pre-existing primary and/or downgaze diplopia are more likely to have persistent symptoms postoperatively that may require strabismus surgery.

KEYWORDS: Diplopia, orbital decompression, strabismus, thyroid

INTRODUCTION

Orbital decompression is a significant cornerstone in the different modality treatments for thyroid-related orbitopathy (TRO) patients. It is effective in treating exposure keratopathy, optic neuropathy and disfiguring proptosis.[1–3]

Various decompression procedures have been described including inferior/medial wall, lateral/deep lateral wall and intraconal fat debulking.[4–5] Although they differ in the extent of orbital expansion and proptosis reduction, each technique may be associated with intra- and post-operative complications such as inadequate orbital expansion, iatrogenic optic nerve damage, new-onset strabismus and diplopia.[2,5–7] New-onset or worsening of pre-existing diplopia is one of the major postoperative concerns for TRO patients who are destined to undergo orbital decompression surgery. Diplopia rate of 18–63% is described in different studies depending on surgical technique.[2,8–13] Obviously primary gaze or downgaze diplopia are of greater concern.

Medial and inferior wall and floor decompression surgeries are associated with up to 30% of new-onset strabismus,[4] whereas deep lateral wall decompression surgeries are associated with 2–15% of new-onset diplopia.[14–16] Results of balanced medial and lateral wall orbital decompression, with or without decompression of the inferior wall, range between 10 and 40%.[9,10,12,17]

As postdecompression diplopia is not infrequent in TRO patients, some of the patients are compelled to go through strabismus surgery. It has been implicated by Ruttum 7 that orbital decompression might be a risk factor for a more complicated course in strabismus correction, with a lower surgical success rate, however there is controversy concerning this notion.[18]

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The purpose of the current study was to characterize postoperative diplopia as a complication after inferior-medial wall orbital decompression procedures in TRO patients in our institute.

METHODS

This study is a retrospective, interventional case series. Medical records of all patients who underwent bilateral inferior-medial orbital decompression for TRO at the Goldschleger Eye Institute, Sheba Medical Center, Israel, from January 1986 to December 2007, were reviewed. The study complied with the policies of the local institutional review board.

Data regarding complete ophthalmic examination, primary and downgaze diplopia and clinical assessment of ocular motility were retrieved from medical records and analyzed. A telephone call survey was made to obtain missing data regarding postoperative new-onset diplopia.

Surgical Technique

All surgeries were performed under general anesthesia by two of the authors (Nachum Rosen and Guy J. Ben Simon). A lateral canthotomy incision was performed followed by inferior fornix incision using monopolar cautery, 3 mm below the inferior tarsal border. Incision was extended towards the caruncle. Inferior eyelid retractors were incised and the rim of inferior orbital floor was exposed. Periosteal sheath was peeled off using a freer elevator and the inferior orbital groove was identified. Bone was broken using suction tip and removed piecemeal. The infraorbital nerve was left as a hammock hanging with the induced floor fracture. Bone removal was extended temporally to unroof maxillary sinus as required and medially towards the maxillo-ethomidal strut. Until recently (4 years) the anterior part of the strut along with the inferior portion of the medial walls was removed in a similar manner using the same incision. In recent years, inferior wall removal was extended towards the strut leaving it intact. Additional medial caruncle incision was fashioned and bone was removed from the middle and posterior ethmoid air cells, with anterior and posterior ethmoid vessels marking the superior edge of dissection.

Periosteal incision was carried out along the border of the dissection allowing orbital fat to prolapse into the induced fracture. Additional blunt separation of fat septae was performed.

Inferior fornix incision was left unsutured, and lateral canthal angle was reformed using absorbable polyglactin sutures. Skin incision was sutured using 6/0 nylon sutures and temporary temporal tarsorrhaphy was placed for a period of 1–2 weeks postoperatively. In unilateral cases the eye was patched using steroid ointment, and in bilateral cases only one eye was patched.

All patients received a single dose of corticosteroids intraoperatively, oral prednisone 1 mg/kg for an additional 3 days postoperatively and dexamethasone–neomycin eyedrops four times daily for a period of 1–2 weeks.

Statistical Analysis

Statistical analysis was performed using a paired samples *t*-test to compare preoperative and postoperative data such as visual acuity, intraocular pressure, and ocular deviations in all positions of gaze. Cross tabs and χ^2 analysis were used to calculate proportion difference for patients with primary gaze and down gaze diplopia pre- and post-operatively. Pearson bivariate correlation was used to evaluate preoperative and postoperative amplitudes of deviations in primary and down positions of gaze. Conversion of Snellen visual acuity to a logarithm of the minimum angle of resolution (logMAR) value was performed. Statistical analysis was carried out using Microsoft Excel 2003 (Microsoft Corporation, Redmond, WA, USA) and SPSS software version 13.0 (SPSS, Inc., Chicago, IL, USA).

RESULTS

Fifty-one TRO patients (30 females, 21 males, mean age of 51 years) who underwent 102 bilateral inferior-medial wall orbital decompression surgeries were included. All but three patients underwent simultaneous bilateral surgery. Demographics of the study population are summarized in Table 1.

Preoperatively, 29 patients (57%) reported primary gaze diplopia. Of these, 13 patients (45%) had persistent or worsened diplopia postoperatively, all of which required strabismus surgery (Figure 1). Eight patients had no symptoms postoperatively (28%), and no data was available regarding postoperative diplopia for the remaining eight patients (28%). Fifteen patients had no primary gaze diplopia preoperatively. Of these, five patients (33%) had new-onset diplopia postoperatively, and only one patient (7%) required strabismus surgery. Figure 2 shows number of patients with pre- and post-operative primary gaze diplopia. No data regarding pre-existing diplopia were available for the last seven patients.

None of the patients who underwent inferior wall decompression alone developed new-onset diplopia, whereas 10/56 (18%) of patients who underwent inferior/medial wall decompression developed new-onset diplopia ($p = 0.03$, χ^2).

Inferior and medial wall orbital decompression had a significant effect on horizontal ocular deviations with increasing esotropic shift (Tables 2 and 3). Patients with

TABLE 1 Demographics of 51 thyroid-related orbitopathy patients who underwent bilateral inferior/inferior-medial wall orbital decompression.

Characteristic		Mean ± SD (Range)[a]
Gender	Male	21 (41.2)
	Female	30 (58.8)
Age, years		51.3 ± 10.8 (19–72)
Grave's duration, months		41.6 ± 51.2 (0–228)
TRO duration, months		27.5 ± 43.7 (0–180)
Follow-up, months		38.6 ± 34.1 (5–162)
Radioactive Iodine Rx, No. (%)	Yes	17 (33.3)
	No	20 (39.2)
	No data[b]	14 (27.5)
Thyroid surgery, No. (%)	Yes	27 (53)
	No	7 (13.7)
	No data[b]	17 (33.3)
Orbital wall decompression, No. (%)	Inferior	46 (45.1)
	Inferior medial	56 (54.9)
Simultaneous recession of Muller muscle, No. (%)	Yes	9 (8.8)
	No	93 (91.2)

TRO, thyroid-related orbitopathy.
[a]Unless otherwise indicated.
[b]Unavailable data from medical records or by telephone survey.

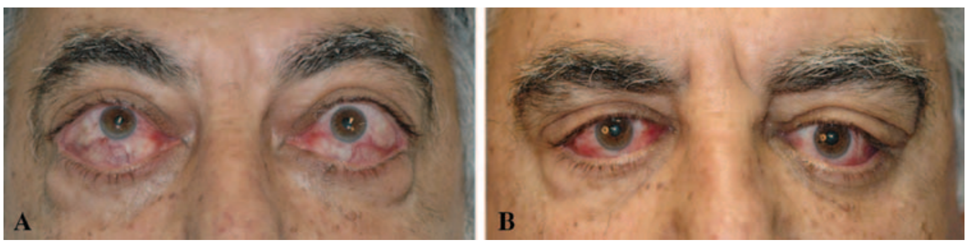

FIGURE 1 (A) Preoperative image of a 58-year-old male with disfiguring proptosis, right optic neuropathy and restrictive strabismus with primary gaze diplopia. (B) Two years after bilateral inferior-medial walls decompression followed by strabismus surgery (eye muscle recession) with good functional and cosmetic outcome.

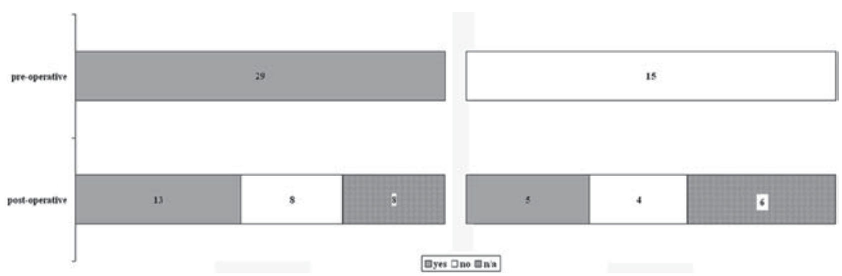

FIGURE 2 Primary gaze diplopia pre- and post-bilateral inferior-medial wall orbital decompression surgeries in 51 consecutive patients (102 surgeries).

pre-existing diplopia experienced a greater esotropic shift postoperatively in comparison with patients without pre-existing diplopia (16 prism diopter [PD] vs. 8 PD in primary gaze for horizontal deviation, and 15 vs. 11 PD in downgaze for horizontal deviations). These differences did not occur in vertical deviations changes.

In all patients Positive correlations were found between preoperative and postoperative horizontal and vertical deviations in primary gaze ($R = 0.81$; $p = 0.002$, $R = 0.83$; $p = 0.001$, respectively, Pearson bivariate correlation), and in down gaze ($R = 0.74$; $p = 0.009$, $R = 0.93$; $p < 0.001$, respectively, Pearson bivariate correlation), Figure 3. Surgery had no effect on vertical deviations or horizontal deviations in all other gaze positions.

Visual acuity remained unchanged after surgery (ΔlogMAR of visual acuity of 0.001; $p = 0.95$, one-sample *t*-test).

Eight patients (17 orbital decompressions) underwent reoperation for various causes such as residual disfiguring proptosis or persistent corneal exposure.

No severe complications such as visual loss or cerebrospinal fluid leak occurred in this group of patients.

TABLE 2 Comparative analysis of 29 thyroid-related orbitopathy patients with preoperative diplopia who underwent bilateral inferior/inferior-medial walls orbital decompression.

Characteristic		Mean ± SD (Range)[a]	*p* value[b]
Visual acuity (range)	Preoperative	20/29 (20/20–20/600)	NS
	Postoperative	20/29 (20/20–20/200)	
Intraocular pressure, mmHg	Preoperative	18.9 ± 5.1 (11–29)	NS
	Postoperative	18.1 ± 6.7 (9–31)	
Horizontal deviations in primary gaze, PD (± SD)	Preoperative	17.4 ± 26.7	0.027
	Postoperative	33.0 ± 18.9	
Horizontal deviations in downgaze, PD (± SD)	Preoperative	20.1 ± 28.0	NS
	Postoperative	35.0 ± 18.7	
Vertical deviations in primary gaze, PD (± SD)[c]	Preoperative	0.9 ± 10.4	NS
	Postoperative	0.6 ± 7.5	
Vertical deviations in down gaze, PD (± SD)[d]	Preoperative	1.7 ± 13.1	NS
	Postoperative	2.0 ± 8.6	

NS, not significant; PD, prism diopter.
[a]Unless otherwise indicated.
[b]Paired-samples *t*-test.
[c]Values refer to esodeviations.
[d]Positive values refer to hypertropia, whereas negative values refer to hypotropia.

TABLE 3 Comparative analysis of 15 thyroid-related orbitopathy patients without preoperative diplopia who underwent bilateral inferior/inferior-medial walls orbital decompression.

Characteristic		Mean ± SD (Range)[a]	*p* value[b]
Visual acuity (range)	Preoperative	20/29 (20/20–20/800)	NS
	Postoperative	20/29 (20/20–20/200)	
Intraocular pressure, mmHg	Preoperative	19.5 ± 3.9 (12–32)	NS
	Postoperative	18.7 ± 4.4 (9–36)	
Horizontal deviations in primary gaze, PD (± SD)	Preoperative	0.0 ± 0.0	NS
	Postoperative	7.8 ± 11.8	
Horizontal deviations in downgaze, PD (± SD)	Preoperative	−0.5 ± 1.0	NS
	Postoperative	10.3 ± 16.6	
Vertical deviations in primary gaze, PD (± SD)[c]	Preoperative	−1.3 ± 15.6	NS
	Postoperative	−4.5 ± 10.4	
Vertical deviations in downgaze, PD (± SD)[d]	Preoperative	−5.5 ± 9.8	NS
	Postoperative	−2.5 ± 5.0	

NS, not significant; PD, prism diopter.
[a]Unless otherwise indicated.
[b]Paired-samples *t*-test.
[c]Values refer to esodeviations.
[d]Positive values refer to hypertropia, whereas negative values refer to hypotropia.

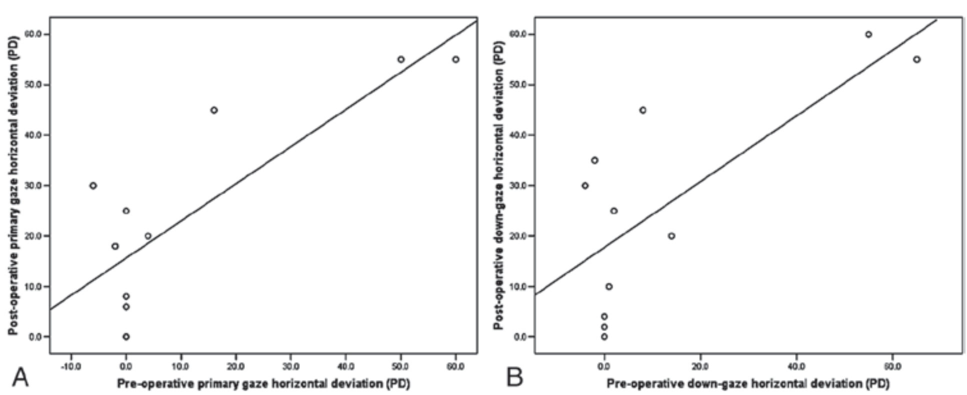

FIGURE 3 Scatter plots of pre- and post-operative horizontal strabismus in primary gaze (A) and down gaze (B) in thyroid-related orbitopathy patients who underwent bilateral orbital decompressions. Positive correlations were found between pre- and post-operative horizontal strabismus. Positive values refer to esotropia and negative values to exotropia.

Fourteen patients (27%) underwent eye muscle surgeries sometime in the course of TRO, due to post decompression strabismus.

DISCUSSION

This study shows that inferior-medial wall orbital decompression is associated with a relatively high rate of primary gaze diplopia. Patients with pre-existing diplopia were more likely to have persistent symptoms postoperatively and to require strabismus surgery after orbital decompression. As expected, surgery increased esotropic shift, most likely because of orbital expansion in the medial orbital region. Our findings further support previous reports regarding medial and inferior wall orbital decompression.[4,6,14,15,19,20]

Postoperative new-onset diplopia may occur in 0–62.5% of orbital decompression, depending on the surgical approach and the extent of bone and intraconal fat removal (Table 4). It seems that more globe displacement either by bone removal or fat removal may be associated with a higher rate of strabismus postoperatively. This should be carefully weighed against the benefit of decompression surgery in each patient, and should be clearly stated to patients before surgery.[2,21] Postoperative new-onset diplopia will be less bearable when the primary indication is cosmetic (e.g., mild proptosis), in comparison with disfiguring proptosis, corneal exposure or optic neuropathy. When primary gaze diplopia exists preoperatively, patients may be more tolerant if symptoms persist after surgery. In few patients diplopia may actually improve after surgery.

TRO patients are often compelled to undergo multiple surgical procedures, including orbital decompression, followed by eye muscle surgery and finally an eyelid recession surgery. Ongoing attempts aim to develop a decompression technique with no to minimal postoperative diplopia. Such a technique will reduce the number of required surgeries, while adopting a "one shot" surgery modality, including simultaneous decompression and eyelid recession surgery. It is accepted that deep lateral wall with intraconal fat debulking and/or balanced orbital decompression (medial + lateral walls) are associated with the lowest rate of new-onset diplopia of 3–5%.[15,20]

Patients who underwent inferior-medial walls decompression developed new-onset diplopia significantly more than patients who underwent inferior wall decompression alone. When performing inferior-medial wall decompression, the surgeon removed part of the anterior maxilla-ethmoidal strut. We believe this may be the reason to the increased rate of diplopia postoperatively. Today, when performing inferior and medial walls decompression (either alone or as a part of three-wall decompression) we use a separate transcaruncular incision, leaving the maxilla-ethmoidal strut intact.

The current study also shows that inferior-medial wall orbital decompression has a significant effect on horizontal ocular deviations with increasing esotropia postoperatively. We assume that this unbalanced decompression technique results in shifting of the muscle cone into the sinus cavities, placing additional

TABLE 4 New-onset primary gaze diplopia after orbital decompression in thyroid-elated orbitopathy in different studies.

Author	Methodology	Type of orbital decompression	*n* (patients) (*n* cases)	New-onset diplopia (%)
Fabian et al. (present study)	Retrospective	Floor and medial wall	51 (102)	33.3
Fatourechi et al.[21]	Retrospective	Transantral orbital decompression	34	44.1
Kalmann et al.[22]	Retrospective	Three walls, coronal approach	125	3.2
Nunery et al.[4]	Prospective	Floor and medial wall	58	25.9
Shepard et al.[12]	Retrospective	Endoscopic medial and extended lateral	11 (18)	18
Wright et al.[23]	Retrospective	Transnasal endoscopic medial and inferior	11 (21)	18
		Transnasal endoscopic medial and inferior with preservation of the inferior-medial bony strut	6	0
Eloy et al.[24]	Prospective	Transnasal	16 (27)	62.5
Linnet et al.[25]	Prospective	Two walls transcranial	30 (50)	3.3
Metson and Samaha[11]	Prospective	Endoscopic decompression using orbital sling	13 (20)	0
		Endoscopic decompression without a sling	24 (38)	30
Ben Simon et al.[15]	Retrospective	Deep lateral wall with intraconal fat debulking	116 (201)	2.6
Ben Simon et al.[20]	Retrospective	Minimally invasive	48 (80)	2.1
Seiff et al.[26]	Retrospective	Transantral with preservation of anterior periorbita	15 (30)	0

stretch on the already tight inferior and medial rectus muscles and exacerbating esotropia and hypotropia. We do not believe that lateral wall removal is superior to inferior/medial wall removal in regard to optic nerve decompression. However, we believe that lateral wall decompression may be associated with less new-onset primary or downgaze diplopia as was shown in previous publications.[14,15]

Fourteen patients of the study population underwent eye muscle surgery due to postdecompression strabismus, with good alignment of both eyes and gain of binocular vision.

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